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EVALUATION OF AN OXIDATION-DITCH WASTE-WATER TREATMENT PLANT IN SUB-ARCTIC ALASKA

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EVALUATION OF AN OXIDATION-DITCH WASTEWATER TREATMENT PLANT IN SUB-ARCTIC ALASKA

A Progress Report

to

Federal Water Pollution Control Administration
Department of the Interior

from

The Institute of Water Resources
University of Alaska
College, Alaska

Project Director: R. Sage Murphy
Associate Professor of Environmental Health Engineering

Period Covered by Report: June 15, 1967 to May 15, 1968

Report Date: May 20, 1968

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SUMMARY STATEMENT

The facility in question was inundated during the disastrous Fairbanks flood of August 15, 1967. Restarting the plant was performed soon thereafter and this report covers only that period until May 15, 1968.

Consistent Biochemical Oxygen Demand removals in excess of 90 percent were achieved even when liquid temperatures as low as 2°C were prevalent. No mechanical failures could be attributable to the cold environment when average air temperatures of -49°C lasted for ten days.

Nitrification by the activated sludge was completely inhibited at liquid temperatures below 10°C.

The plant appears to be the most efficient biological treatment facility located in the severe climate found at high latitudes. Further investigation is needed to completely evaluate the biological kinetics during winter and summer operation.

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A PROGRESS REPORT ON THE EVALUATION OF AN OXIDATION DITCH WASTEWATER TREATMENT PLANT IN SUB-ARCTIC ALASKA

Introduction

The first months of the study were devoted to acquiring equipment, setting up the plant laboratory, and designing experiments. On August 15, 1967 the Fairbanks area was subjected to a record flood which topped the walls of the plant. All activated sludge was lost, much of the mechanical equipment was silt-laden, and the plant became inoperative for a period of two weeks. Start-up after the flood was rapid but some mechanical equipment failures prevented good operation until approximately October 1, 1967, at which time regular data acquisition was begun.

Although the flood prevented a maximum amount of data to be taken during the warm summer months, it did afford the opportunity for investigation of the start-up of the plant during the cooler fall months.

Plant Description and Operation

Figure 1 shows the plant flow pattern and a table of important dimensions. The ditch has a rectangular cross-section, common central wall (for maximum conservation of heat), and is constructed of concrete block. All portions of the ditch are exposed to the atmosphere. The clarifier is housed in an unheated building adjacent to a small heated office-laboratory structure. The design of the plant utilized maximum conservation of heat.

One unusual feature of the plant is the housing over the two rotors used to prevent ice formation. In addition, a matting was hung from this housing in the water to a depth of one inch to prevent the spray from forming ice near and around the rotors. These mats were not installed during the first year of operation and considerable maintenance problems caused by ice formation were encountered. The mats completely alleviated this problem.

Average waste flow was 172,000 gallons per day with the maximum daily being 203,000 gallons. The average flow represents a plant detention time of 2.3 days.

Results and Discussion

Figure 2 depicts the average influent waste, oxidation ditch mixed liquor, and ambient air temperature during the severest periods of the winter of 1967-68. The

discontinuities in the influent and ditch temperatures were during periods when the plant was "down" for repairs. It should be mentioned that most repairs were necessitated by equipment being worn-out due to damage incurred in the August flood. Ice cover was never evident during the winter. Effluent temperatures were generally within 0.1 - 0.3°C of the reported ditch temperature.

Figure 3 shows the average percent BOD removal and average ambient air temperature versus time for the most severe winter period. As can be seen from this figure and Table 1, exceedingly good operation was achieved despite the low winter temperatures.

Although the plant was designed to be operated with two rotors, only one was in operation throughout the study period. Dissolved oxygen concentrations in the effluent ranged from 1 mg/l to 6 mg/l and could not be directly related to other process parameters. Influent D.O. in all tests were less than 0.5 mg/l. Figure 4 shows D.O. profiles in the ditch at two depths. The steepness of the D.O. gradient could not be attributable to ditch liquid velocities which were found to be 0.9 feet per second, a value comparable to published recommended velocities of 1 ft/sec. Sludge was extracted from the bottom of the ditch and anaerobic activity could not be detected.

Mixed liquor suspended solids were determined throughout the study period. Figure 5 depicts the suspended solids carried in the ditch and in the effluent versus time. It can be seen that an increase in effluent solids did not always coincide with a decrease in mixed liquor solids, which would be evident if an auto-induced sludge wasting event were taking place. Significantly more sludge was found near the bottom of the ditch than near the surface, but, as mentioned earlier, no anaerobic activity was evident.

Nitrification was never evident at liquid temperatures below 10°C, which would be expected from basic knowledge known about the microorganisms reponsible for this process. Nitrate concentrations did reach a maximum of 8.4 mg/l when the liquid temperature was 13.5°C.

Conclusions

The above data indicate that the oxidation ditch has great promise as a treatment device for biodegradable wastes in regions of low temperatures. Maintenance and operation costs were extremely low, while 92 percent BOD removal was attained for the winter months.

Proposed Future Work

1. An intensive study of the operation during the rather warm summer months is warranted to insure the plant is operating efficiently during that period.

Of greatest significance will be the presence or absence of algae, a detrimental factor for this type of facility. The summer operation is somewhat different than results reported by others because the plant is subjected to nearly 24 hours/day solar radiation during these months.

2. Although BOD removals were shown to be excellent for the winter months, suspended solids balances were found to be exceedingly difficult to make. A large part of the second year's work will be devoted to this parameter, the data leading to a better understanding of the microbial kinetics within the plant.

3. In conjunction with the solids data a concentrated analysis of the dissolved oxygen levels will be made this year which can be correlated with loading and solids information, yielding additional information on the kinetics of the system.

4. Nitrogen balances, pH, hydraulic loading, and temperatures will continue to be performed during the second study year.

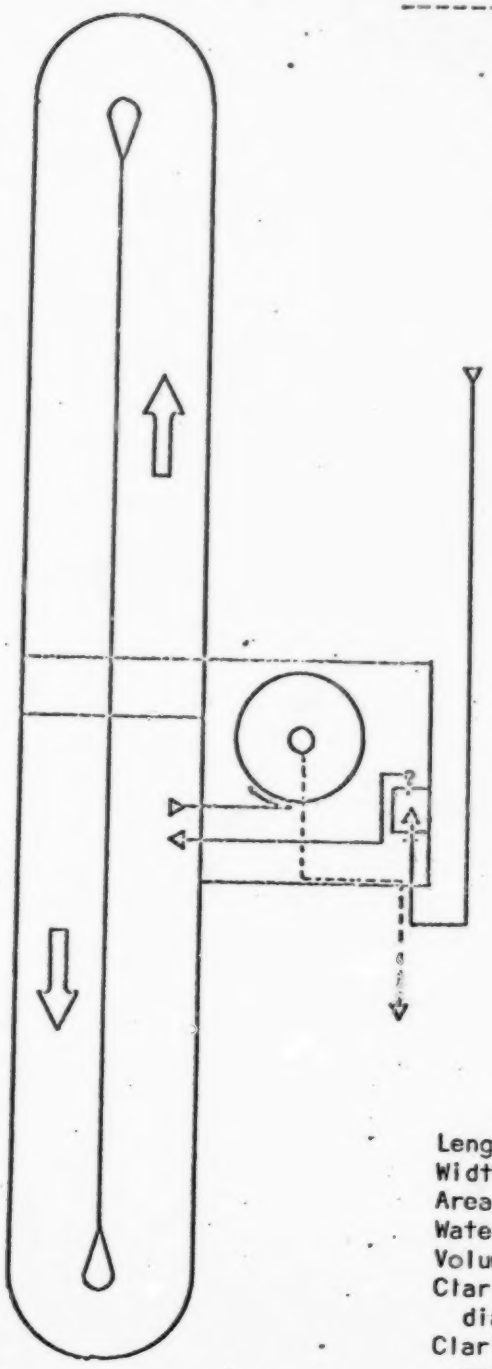
Reference:

Grube, Gareth A., "Evaluation of an Oxidation Ditch Activated Sludge Plant in Sub-Arctic Alaska," Master's Thesis, University of Alaska, May, 1968.

FIGURE 1

Schematic Diagram of Plant ——▷ Influent Waste

------▷ Treated Effluent



General Dimensions

Length of ditch	=	305.3 feet
Width of ditch	=	19.75 feet
Area of ditch	=	10,348 sq. ft.
Water depth	=	4.33 feet
Volume	=	333,000 gallons
Clarifier diameter	=	30 feet
Clarifier volume	=	54,000 gallons

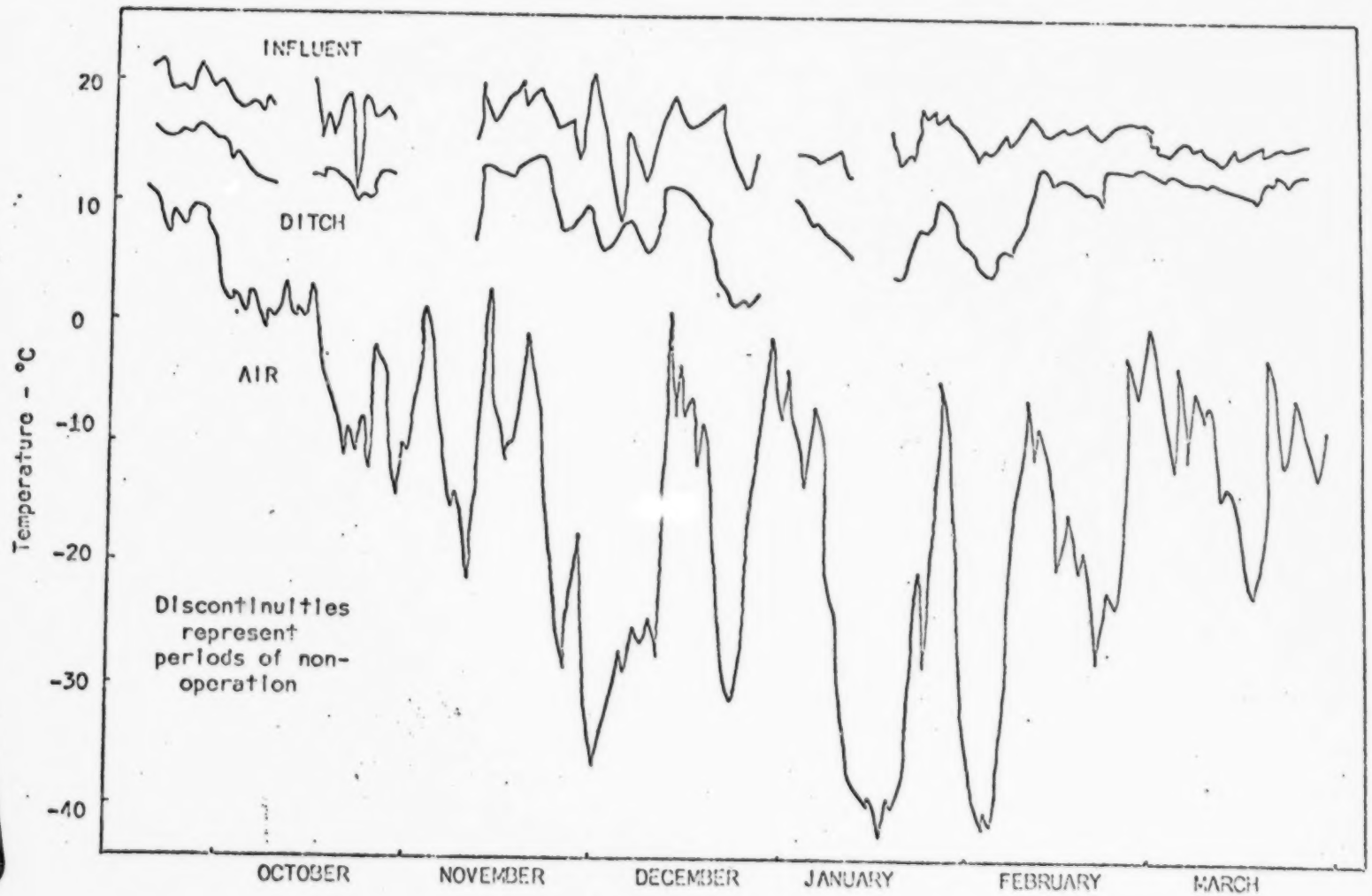


FIGURE 2 - Temperature Records

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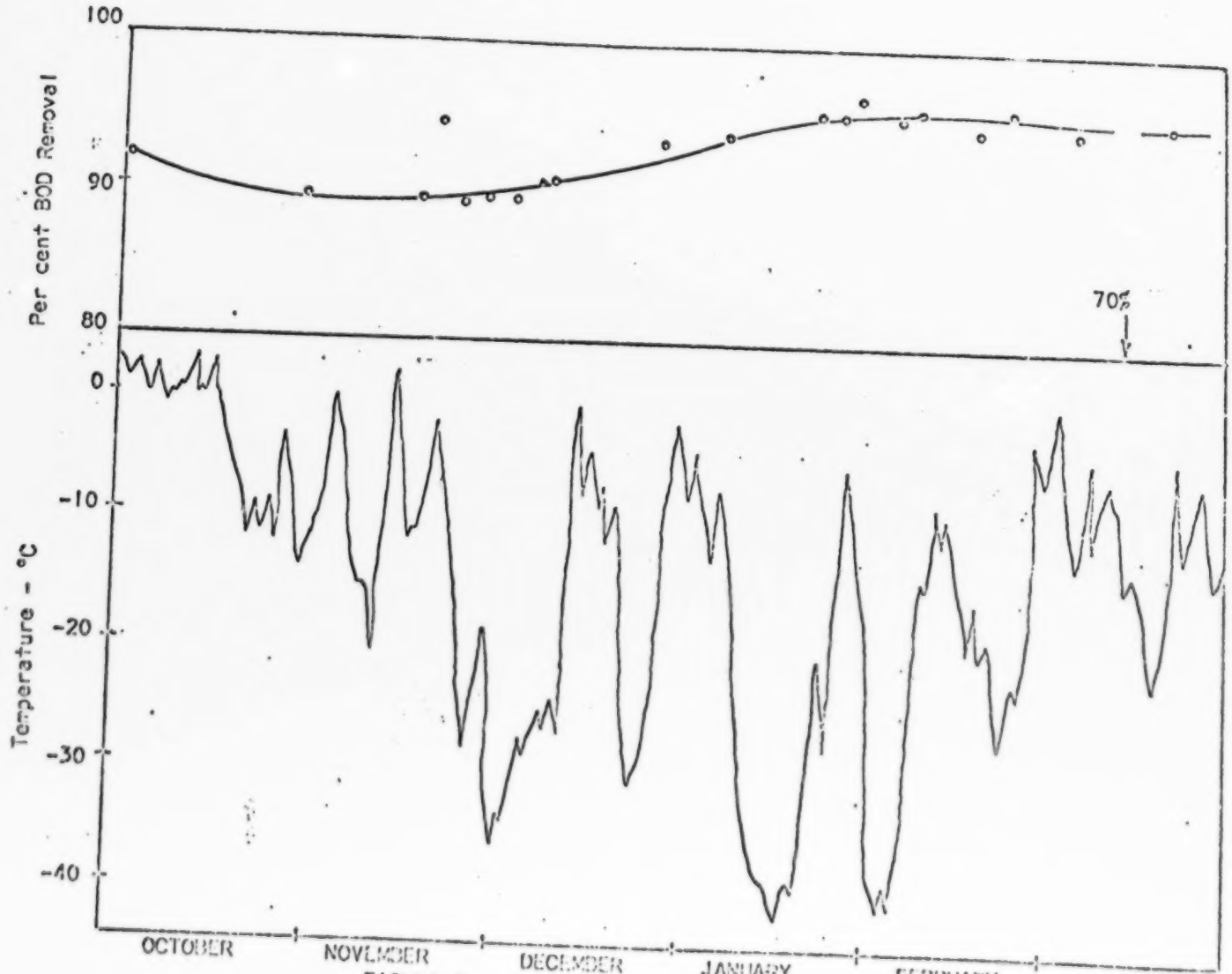

FIGURE 3 - Per cent BOD Removal and Temperature

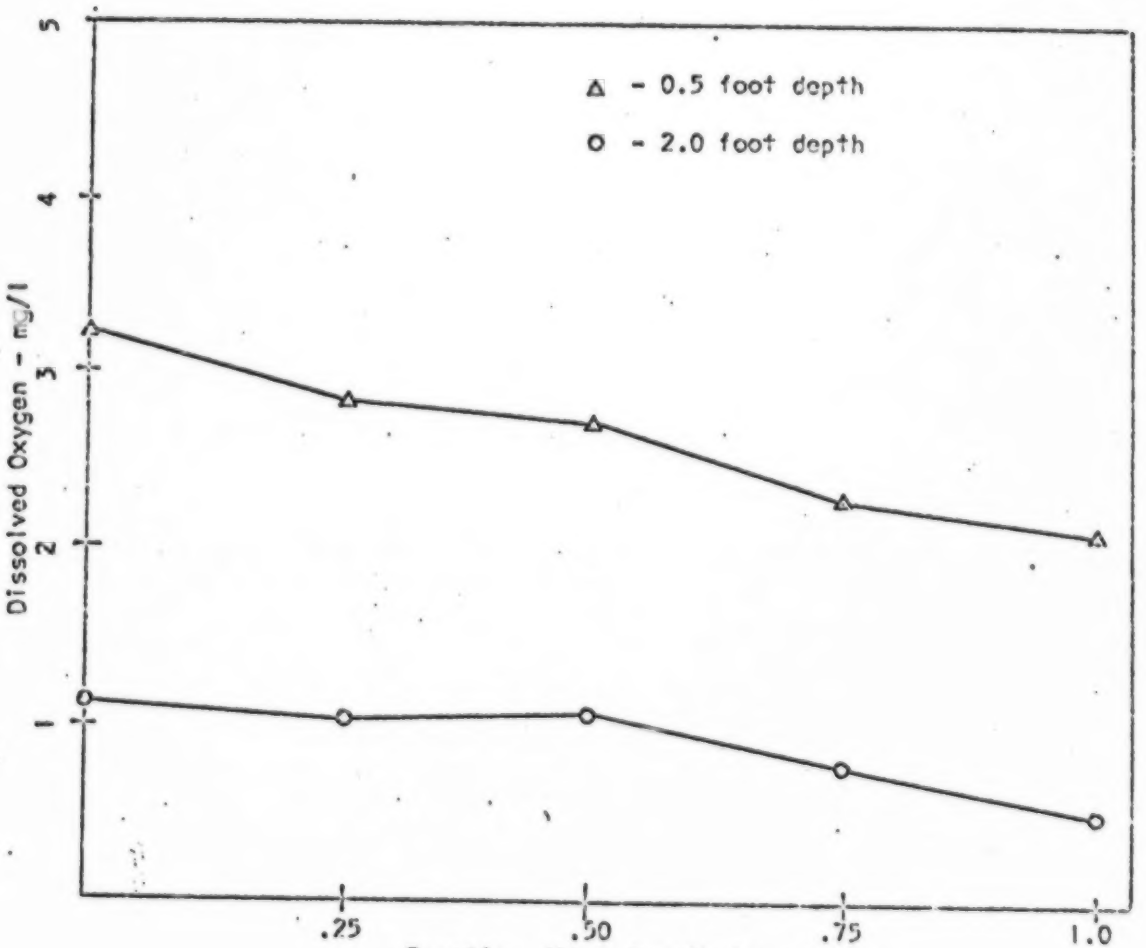

FIGURE 4 - Dissolved Oxygen

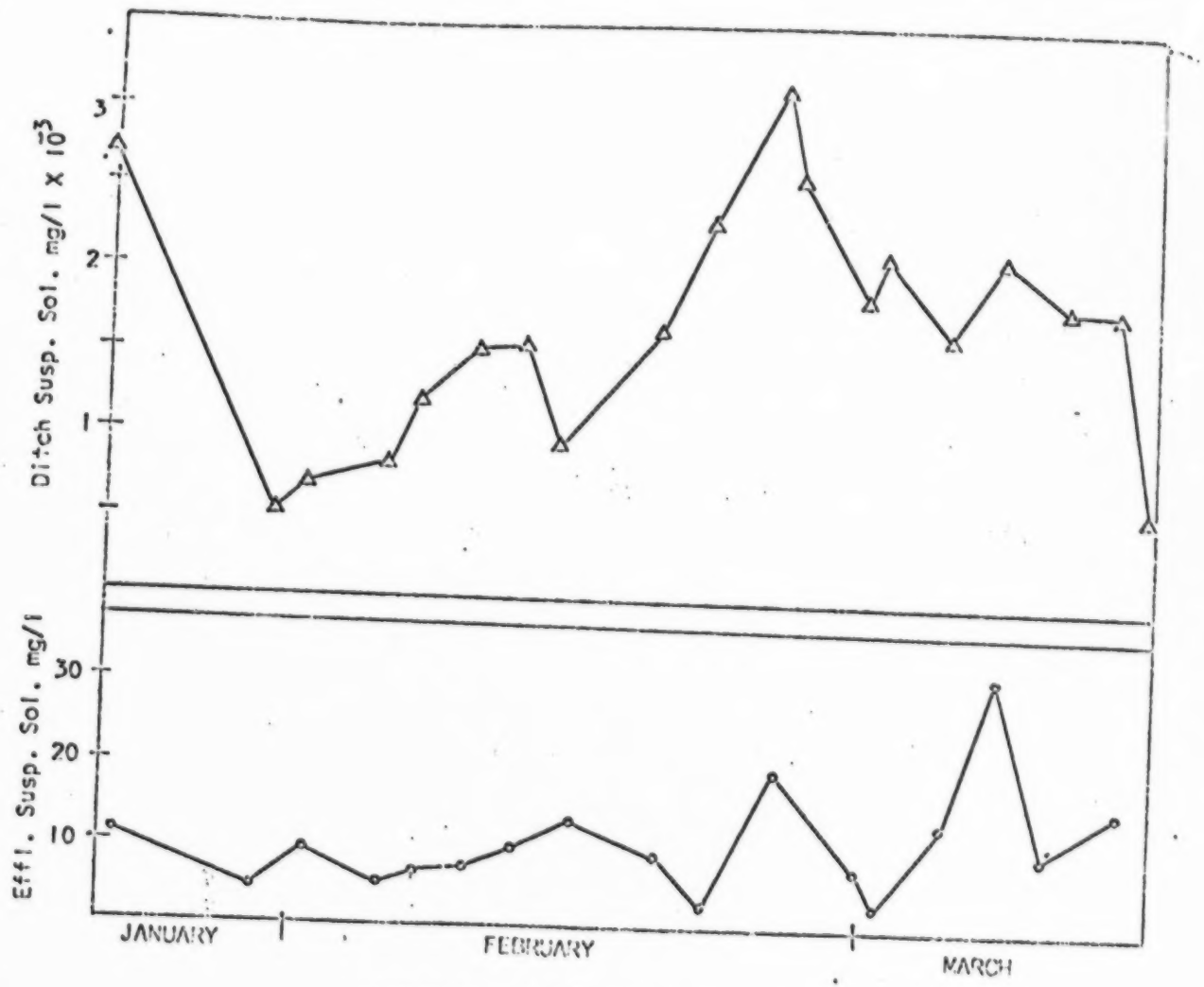

FIGURE 5 - Ditch and Effluent Suspended Solids

TABLE 1

Representative BOD - COD Relationship

Date	Inf COD	Inf BOD	Eff COD	Eff BOD	Percent BOD Removal	Percent COD Removal
2-28	543	211	50	25	88	92
3- 4	458	251	39	9	96	92
3- 6	344	84	56	10	88	83
3-15	973	610	861	177	71	11

Proposed Detailed Budget for Second Project Year

	Grant	Other Sources
A. Personnel		
1. Principal Investigator		
R. Sage Murphy - 3 months @ $1625/mo	$ 4,875	
2. Research Engineer		
1/3 time for 12 months @ $1000/mo	$ 4,000	
3. Plant Operator	---	$3,000
	$ 9,875	$3,000
B. Equipment		
1. No additional equipment requested from project funds		
2. Miscellaneous equipment from other sources		$ 300
		$ 300
C. Consumable Supplies		
1. Glassware	$ 500	$ 500
2. Chemicals	$ 500	$ 500
	$ 1,000	$1,000
D. Travel		
1. Presentation of results at the 24th Purdue Industrial Waste Conference	$ 650	$ 200
	$ 650	$ 200
E. Other Expenses		
1. Printing and Publication	$ 500	$ 150
2. Secretarial	$ 200	$ 300
	$ 700	$ 450
Total Direct Costs	$12,250	$4,950
Indirect Cost Allowance (15% Total Direct Costs)	$ 1,838	n.a.
Total Budget	$14,088	n.a.